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Studies on Mortars and Concretes with Pozzolonic Admixture

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ABSTRACT: *Due to the steep increase in the cost of cement which is the main building material commonly used, the constructional costs are going up. In the present contest of housing the millions, various programmes are getting upset because of the increased cost of constructions. In these contexts, various alternatives are being tried to be used as full or partial replacement of cement to reduce its cost. Pozzolime is one such material manufactured locally using lime and clay. Its cost nearby 1/3rd of that of cement. Though pozzolime has been put use by builders to certain extent, its strength properties are not well understood to relies its full potential and use, it is necessary to carryout detailed experimental studies on the strength properties of pozzolime in combination with cement. In the present experimental investigation, pozzolime is used as been partial replacement to cement in various proportions; specimens of mortars and concretes are cost and tested for compressive strength at different ages. The results are compared with those of the fly ash. The results indicate that desirable strength properties can be achieved in mortars and concretes by using pozzolime as partial replacement to cement. It may be concluded that cost affective mortars and concretes can be prepared using pozzolime admixture. This would help substantially in reducing the cost of construction.*

Keywords: **Compressive** *strength; Flexural strength; Fly ash; Pozolime*

I. Introduction

The problem of housing is very acute in India. In spite of the hectic construction of activity involving the construction of millions of dwellings units, being carried out in the country, still there is a wide gap between the demand and the supply. By the turn of the century, the housing needs will be much more. Many of the mass housing programmes are sufficiency with escalation of construction costs, the chief building materials like cement, bricks, wood, etc are soaring up day by day advisedly affecting the building programmes.

In this context, attempts have been made to tryout alternative and new building materials for use to cut down the cost of building construction. To reduce to cost of the cement various admixtures are being tried along with cement. Similarly durable and cost effective bricks and blocks have been developed and are being used instead of the conventional burnt clay bricks.

1.1 Alternative Materials For Cement

Though cement cannot be replaced completely by any other alternative material, at least part replacement of cement can be done with the help of suitable alternatives. Making use of industrial ways like fly ash, blast furnace slags etc. More cost effective cement is being manufactured. Attempts are being made to replace cement partly in concrete by using pozzolonic materials like fly ash, stone dust, brick powder, rice husk ash, etc.

1.2 Pozzolonas Their Characteristics And Uses

The above mentioned pozzolonas basically consists of silica has to main constituent and they inert by themselves. But by combining with prelim present in cement they help in producing useful compounds of cementitious value. The reactive silica content in each depends on the type of pozzolona, it source and its fineness.

In general it may be mentioned that a suitable pozzolona can be used as a part replacement to cement in the preparation of mortars or concretes. They help concretes in gaining strength over longer ages. The proportions like workability, durability etc are improved with the addition of pozzolona.

1.2.1 Flyash

In the context of the increasing scarcity of raw materials and to urgent need to protect the environment against pollution hazards to coal ash utilization assumes great national importance. Better utility of industrial wastes helps in checking the environmental hazard and ecological in balances. Fly ash is one of such wastes generated from coal fired thermal power stations currently posing as serious operational constraint and environmental hazard. In India against to present installed capacity of around 30,000 MW of thermal power, the annual generation of fly ash would be in the order of thirty million tons. The coal inputs to power stations of 30-50% ash content. By the turn of century, thermal power plants of the country have to handle about 90 million tons/year of ash management of coal ash of this magnitude is a matter of great concern in the years to come to deal with from the point of view of protecting the environment from the pollution hazards and for finding required space to dump to waste material and to mobilize to needed resources.

1.2.2 Properties Of Flyash

a. Fineness: Fly ash collected electro statically is finer then to fly ash elected mechanically. A reliable melted of measurement of fineness is found to be sieving as a single sieve viz 45 microns. Through it has short comings, thus method is simple, reliable, and cheap.
b. Density: The average relative density of fly ash is between 1.9 to 2.4, about 2/3 of Portland cement. The loose bulk density of fly ash is about 800 kg/cubic meter.
c. Colour: It ranges from cream to dark grey depending on the presence of unburnt carbon and iron content.

1.3 Aim Of The Present Study

The present project work aims at the study of structural application of pozzolime. As already mentioned pozzolime which is produced from lime and clay is locally available as a cost affective alternative to cement.

Through pozzolome has been put to use by the builders to certain extent particularly in masonry mortars, no attempts has been made to try it in concretes. The present experimental investigation is aimed at the study of the properties of not only mortars also concretes using pozzolime as part replacement to cement. The study compresses of the following.

a. Preparation and testing of samples of masonry mortors (1:6) using pozzolime as part replacement to cement at four selected percentages.
b. Preparation and testing of specimens of cement concrete (1:3:4) using pozzolime as part replacement to cement at the four percentages. The strength characteristics of the specimens are to be studied at different ages.
c. Preparation and testing of motors and concretes with fly ash admixture using various percentages of fly ash as replacement to cement.
d. Comparison of the results obtained using the above two types of admixture

1.3.1 Importance Of The Present Study

Based on the results of the present study recommendations are proposed to be made on a definite percentage of pozzolime that can be used as part replacement to cement in mortors and concretes. The results would help in to preparation of cost effective masonry motors and concretes using pozzolome admixtures. By putting these results in to practice considerable saliny can be achieved in the cost of construction of various types of buildings. This would help the variousmass housing programmes which are suffieciently for want of funds. The problem of shortage of houses in the rural and urban mass has to be rackled by using cost affective alternatives like pozzolime.

1.4 Materials

1.4.1 Ordinary Portland cement

43 grade ordinary cement of Raasi Brand has been used in this investigation. The Cement used has been tested for various properties as per IS 4031 – 1988 (Ref:No 23) and found to be confirming to the various specifications of IS:8112 – 1989 (Ref:No24).

1.4.2 Pozzolime

Pozzolime has been obtained from the local market. Though to complete manufacturing process of pozzolime is not disclosed by the manufacturers, it is understood that pozzolime is prepared by burning together lime and clay (equal proportions) under controlled conditions and grinding the resulting product the required fineness.

1.4.3 Flyash

The fly ash which is used in the present experimental work has been obtained from Vijayawada thermal power station of Andhra Pradesh. Specific gravity of fly ash is found to be 2.11. Blains fineness of fly ash is found to be 4610 cm2/gm. Table gives the analysis of fly ash sample obtained from Vijayawada thermal power station which shows that the fly ash used confirms to the various specifications IS 3012 – 1981.

1.4.4 Fine Aggregate

Sand obtained from local source has been used as fine aggregate. The same is free from clayey matter, silt and organic impurities. Sand has been tested for various properties like specific gravity, bulk density etc., in accordance with IS 2386 – 1963 (Ref 25) and to results are shown in table 3.3 Grain size distribution of sand shows that it is close to zone of IS 383 – 1970 (Ref No. 26).

1.4.5 Course Aggregate

Crushed angular granite metal from local source at Kukatpally,Hyderabad is used as course aggregate. It is free from impurities such as dust, clay particles and organic matter etc., course aggregate has been tested for various properties such as specific gravity, bulk density etc., and test results are shown in table .Particle size distribution of coarse aggregate as shown in fig. shows that the metal confirms to single sized aggregate of 2.0 mm nominal size of IS 383 – 1970.

II. Review Of Literature

Different types of studies have been made by different authore and researchers in using certain types of pozzolinic materials as admixtures in mortors and concretes. In general various pozzolonas are inert by themselves, they react with prelim present in cement and contribute towards production of construction material. In reactive silica content in pozzolona depends as its nature, comparition and finess. Thests conducted on different types of pozzolonas by various researchers are reviewed herein.

Studies On Flyash Admixture In Mortors And Concrete Production And Utilisation Of Flyash

M.Raghavendra (1) discussed to utilization of fly ash in manufacture of cement P.V.Raja Ranga Rao , and M.S.S.Subramanyan (2) of APSEB Hyderabad gave the details of fly ash productions its properties etc in Andhra Pradesh. The Author mentioned that out of millions of tones of fly ash being accumulated near the various thermal power station in A.P. only a small portion is being utilized for the manufacture of cement and concrete. The authors are also discussed about the possible applications of fly ash L.V.A. Sesha Sai and J.Rageswara Rao (3) reviewed fly ash utilization in concrete. The authors discussed the properties of fresh and hardened concretes' having fly ash contents.

Characteristics Of Flyash Concretes

L.V.A. Sesha Sai and S. Venkateswara Rao (4) discussed the characteristics of fly ash in concrete making. The authors studied different mortors and concretes with different proportions of fly ash. The authors concluded that by using fly ash from Ramagundam and Vijayawada thermal power stations suitable and useful mortors and concretes can be made.

N.G.Bagavan and H.G.Sainath (5) studied different properties of flyash concretes of three grades. The author concluded that flyash can be used for both reforced and pre – stressed concrete structural members. Nearly 20-25% saving of cement can be achieved by this. S.C.Patodiya (6) developed structural grade concrete using high flyash contents.

The author concluded that large value utilization of flyash is structural grade concrete is technical and economically feasible. The author further discussed the other uses of flyash concretes. K.K.Jain and S.K.Sahu (7) studied accelerated curing of structural concrete with flyash.

Building Components With Flyash

B.L.P.Swamy, P.Syamasunder et al (8) studied the strength characteristics of cement concrete building blocks using flyash admixture on the basis of studies made the authors concluded that concrete building blocks whiopch are cheaper 20-25% comparatively commercial block can be manufactured using flyash admixture. Saving is more in the case of non loading bearing units.

M.Siva kumar Goud (9) studies the effecxtive of flyash on strength of roof tiles the author concluded that in optimum ratio 1:2 between cement and flyash gives adequate strength. R.C.Sharma (10) discussed the properties of auto charged aerated concrete made flyash. He discussed its different properties and recommended it as a complete building system. P.R.Rao (11) B.N.Iyer discussed about the preparation of bricks etc using flyash with day.

Blast Furnace Slag For Cement Manufacture And Its Applications

Portland slag cement is manufactured by mixing together of granulated slag with Portland cement clinker slag is available as in industrial waste product from different steel factories. Slag available from steel plant is found to be of superior quality by mixing about 30% granulated slag with Portland cement clinker and grinding them together to the desired degree of fineness. Portland slag cement is manufactured. It is more cost effective and processes certain advantages.

T.R.Seshadri (12) gave details of production of Portland slag cement in India. He discussed the various properties of PSC like strength development. He recommended slag cement for use in coastal environment. The various other advantageous were given by the author.

Development Of Fal – G Cement, Alpm Cement And Application

Fal –G is a ground blemd of flyash, lime and calcinad gypsum in suitable properties, which yield hydraulic strength in the order of 30-40 N/mm2 by rendering totally a water impervious hardmass, developed based on a cement theory called "Crystallo-mineral combination of setting behavior". This theory says "A weak crystal formation can be made good for attaining healthy cohesive bond if compensatory". In this approach, the strength of flyash which is weak in spite of lime reactivity, is invigorated in the presence of gypsum by which the later induced the formation of ettringite of course, with a regulated pace and quartum accelerating the setting rate and increasing the early strength.

Fal – G composition: Once flyash is analysed for its lime reactivity and relevant strength development, the next step deals with addition of calcined gypsum to flyash lime mix. Gypsum principally gets reacted with alumina of flyash, in the presence of lime, formulating into monosulphate (3 Cao A12 o3 Ca So4 2H2o) and efftringite (3 Cao All o3 3Ca So4 31-32 H2o). In other words the optimum gypsum requirement accomplishes the formulation of fal G cement with strength developments in the range of 250-450 kg/cm2 depending on flyash C.Ayyanna studied and banumati dass (13) studied the mix design of fal-g conducted on m30 strength of neat fal-g has indicated that 1 ½ times of its dosage by wright, as against OPC keeping the other aggregates same, renders a morter or concrete of parallel grade strength.

Workability: for 15 grade concrete has not shown any slump unlike OPC. The additional 50% input of fal-g cement might have rendered relatively better cohesion for the wet concrete to show this phenomenon. Hence ,a different approach to study the workability of fal-g concrete has to be developed.

C.Ayyanna and Banumathi Dass (13) concluded Fal – G cement consumes there industrial wastes and as low energy as 150 k cal/kg, as against 900 K,Cal/kg of OPC imports maximum thrust for Fal – G production and utilization.

N.Kalidas and N.Bhanumathi Dass (14) concluded the testimonial life of lime mortor through its manifestators in pyramids, temples, forts etc for centuries together should alloy the fears of durability of Fal – G cement, where the latter is a product of improved chemistry and technical virtues.

Through Fal – G has all the Virtues to prove its edge as the formidable hydraulic cement, enormour research on both manufacturing and applicational science of the product is necessary to optimize it and tap its fullest potentiality.

Alpm Cement

ALPM is a pozzolonic cement binder. The origin of the pozzolonic cement can be traced back to the ancient constructions in Egypy, Rome and also to some of the present day living examples in great Britan and U.S.A.

ALPM is basically a pozzolonic cement binder imbued in itself cementing properties and gives lasting benefit when used in a properway. Some of the properties P.Veerabadra Rao (15) discussed and concluded that ALPM is one of the best avnues for flyash utilization and covered by Is 10772:1983 which specifies use of flyash with not less than 3.0 H/mm2 as lime reactivity value. The ultimate product strength specification range between 80 kg to 15 kg/cu2.

Use Of Stonedust In Mortors And Concretes

In India crushed stone fine aggregate is available in abundance as a by-product from stone crushers. The possibility of using this crushed stone dust in place of sand in the construction works assumes great importance when river sand is costly especially in upland and interior regions. At present the crushed stone dust in place of sand is being used with advantage in mass concrete construction presently in Hyderabad, crushed stone dust is being used in the manufacture of small precast structural units such as R.C.C. jollies, steining rings for walls flowers pots, water storage tubs, etc., studies for conducted at R.E.C. Warangal on the effective of replacement of sand by stone dust in mortors and concretes. The various strength properties were studied. It was concluded that there is increase in the compressive strength cement mortor and concretes when sand was replaced by crushed stone dust upto the certain percentage. Stonedust available locally used in the investigation.

Rice Husk Ash Cement

Rice husk is an agro industrial waste product available in plenty both in rural and urban areas. General Rice husk used as a fuel in lime kilm and Brick Kilns.

The Ash available after burning rice husk under control conditions when ground to the regional degree of fineness become an active pozzolonic material its silica reactivity is high and can be made use in the preparation blended cements.

Studies were conducted at J.N.T.U. college of Engineering Hyderabad, on the strength properties of mortors and concretes prepared by using rice husk ash blunded cement. Upto certain percentage of rice husk ash mixed with cement, it was observed the strength was increased. It was concluded that this blended cement is useful has a cost effective building material.

Lime Pozzolona Mixtures

Nagireddy (16) tests on brick pillars using four proportions of cement mortor, two proportions of lime mortor and two types of mud mortors. Also tests were conducted replacing sand in mortors fully as well as partially by stone dust to study the effect on mortor strength as well as masonary strength and the following conclusions were arrived

(a) replacement of sand in binding mortors with crushed stone powder by 50% and 10% does not decrease mortor strength to an appreciable extent.
(b) Soil having the angle of friction 0/=2 0 and to cohesion e=0.525 kg/cm2 used in mud mortor gives as much strength as that of 1:8 cement sand mortor.

Gangadharam and Nagireddy (17) have conducted tests on nine proportions of lime flyash mortors to find the effect of proportions of mix, water binder ratio, compaction curing conditions, age, grinding of fine aggregate on the strength workability and performance of mortors. Also the increase in volume of mortor for different proportions was measured and the following conclusions were arrived.

a. Optimum water binder ratio, to attain maximum strength in mortor with reasonable workability was 0.60.
b. 24 hours of air curing yielded 25% to 30% increase in strength.
c. As the aggregate increased in lime mortor from 1:2 to 1:3, the strength decreased by 30%.

Sharpe R.W. (27) has developed on mortor for rising damp studies 25 mm cube specimens of mix 1:3:20 by (wt time – pozzolona) sand where ground brick powder is used as a pozzolona yielded 21.5 kg/cm2 strength at 28 days when fuel ash is used as a pozzolona the strength obtained is 9.3 kg/cm2.

Mac Gregor J.S. (18) conducted tests at Columbia university and showed that the lime cement sand composite mortor of mix 1:1:6 (by weight) have got a higher strength then thant of mix 1:3 cement sand mortor. Dalmar L.Blown (19) has summarized the results of several investigators.

The first test programme arrived at the comparisions between naturally graded masonary sands and the same snds regarded to a specific size distribution essentially with in limits of specifications C144 ASTM.It was found that.

Water requirements of masonary mortor for a given sand grading varied greatly among the different sources. For any given source the w/e ratio was an inverse of the fineness modules, hence to effective of regarding depending depends upon whether the original fineness modules was higher or lower than that of the standard grading used as the basis for comparision kaliya sundaram et al (20) have carried out the studies in the soil mechanics and Research division P.W.D. Madras and concluded that.

a. The proportion of pozzolona concrete can be on similar lines to ordinary cement concrete provided ratio W(C+P) ratio of the former is suitably reduced to obtain the same rate of strength development at early ages.
b. A certain minimum cement content is absolutely necessary for pozzolona action to develop to required strength.
c. Variation in lime reactivity and fineness of fly ash do not cause very siginificant variations in strength of concrete.

Ghosh and Ramlal (21) have conducted the experiments of the study the strength- development characteristics of lime pozzolona - send mortors and the following conclusions are draw.

a. The strength of lime pozzolona mortor depends on the lime reactivity of the pozzolona used. Burnt clay pozzolona having higher lime reactivity then flyash yields improved mortors both at 7and 28 days.
b. The strength of lime flyash mortor registers marked improvement at 28 days compared to the 7 day strength.

c. With 25% replacement of burnt clay pozzolona by flyash the strength of lime blended pozzolona mortors either approaches or even exceeds that of lime burnt clay pozzolona mortors.
d. It is possible to obtain all the difficult grade of mortors normally used in masonary construction by having suitable lime pozzolona mixure as binder.

Sri Hari K (22) conducted tests on three proportions of lime mortor three proportions of cement mortor, sin proportions of lime pozzolona sand composite mortor, tested for maximum compressive strength using three rations of water binder for lime mortors and determined the most optimum water binder ratio for lime cement sand mortor and lime pozzolona sand mortor which gives maximum strengths. He also conducted a few tests on drying shrinkage of the above said mortors. The following are the outcome of his investigations.

The decrease in drying shrinkage for lime pozzolona sand composite mortors over that of lime mortors is about 50% and for lime cement sand composite mortors over that of cement mortor is about 11%.

Tests were conducted at R.E.C. Warangal on mixtures containing high lime flyash brick powder. Small doses of cement gypsum plaster (Low grade variety) was used as additions for hastening the strength process. Through study with regard to the compressive strength at various ages of ten varieties of composite mortors was prescribed.

1:1:3 (I.F.S), 1:1:3 (L.P.S.), 1:1:1/4:3 (L.F.C.S.), 1:1:1/4:3 (L.P.C.S.),1:1:3 (L.B.C.S.),1:1/20:3 (L.P1.S), 1:1:1/20:3 (L.F.P1.S), 1:1:1/20:3 (L.B.P1.S) 1:1:1/20:3 (L.P.P1.S,).

Concretes 1:1:3:6 (L.F.S.CA) 1:1:3:6 (L.P.S.CA) 1:1:1/4:3:6 (L.F.C.S.A.). 1:1/20:3:6 (L.P1.S.C.A) 1:1:1/20:3:6 (L.B.P1.S.C.A.) were prepared and tested. The relative cost is workout. The following conclusions were drawn.

a. In the case of lime flyash composite mortors there is 12% increase in strength at the age of 18 months compared to the 28 days.
b. In the case of lime pozzolona composite mortors by additing cement (1/4 quantity of lime) the strength is increased by nearly 25% at the age of 21 months.
c. In the case of composite mortor with brick powder the strength increased is not encouraging and brick powder was found to be not effected.
d. Similarly brick powder is found to be is not very effective.
e. Addition of such quantity of cement helps in acquiring of early strengths in the case of lime pozzolona concrete.

Development Of Pozzolime

The extensive studies conducted on the characteristics and applications of lime pozzoloma mixtures gave away for the development of pozzolime a cost effective building material which can be used as replacement to cement.

The locally available pozzolonic is manufactured by burning together lime and clay (nearly equal proportions) and by grinding the resulting ash to the required fineness. It is pozzolonic in nature and processes reactive silica to certain extent pozzolome is being used as part replacement to cement i.e. masonary mortors.

There is no clear understanding of the complete physical properties of pozzolime. Studies have not yet been conducted with applications of pozzolime in concretes.

III. Experimental Procedure

3.1 Studies On Cement & Pozzolime Mortor Mixes

In the present investigation pozzolime is used as a portion of the total cementations material in the particular concrete mix in various percentages ranging from to 75. It is the well established fact that the compressive strength of pozzolime concretes are indirectly indicated by the basic compressive strength of cement pozzolime mortor mixes. For demarming the basic compressive strength of cement pozzolime mixes, mortor cubes are prepared, compacted, cured, and tested in the manner described in IS 4031 (part 6) 1988. In this test cement plus pozzolime and sand in the ratio of 1:6 are mixed in dry state thoroughly in a non porus enamel content pozzolime ranges from 0 to 75. Then water of quantity (p/4+ 3.0) % of confirmed weight of cementitionsmaterial and sand is added gradually and all ingradients are mixed in the wet state until a mix of uniform colour is achieved. “p” is the normal consistency of cement used. The prepared mortor is filled into the cube moulds of size 10 cm by 10 cm and kept for 24 hours at room temperature. Then specimens are removedfrom the moulds and cured in curing tanks with clean water for the required period and tested for compressive strength. The average strength of the specimens for each period and percentage replacement of cement by pozzolime is reported a compressive strength of the cube. These compressive strength values with various percentage replacement of cement by pozzolime are shown in table.

3.2 Studies On Cement + Flyash Mortor Mixes

As explained in 3.3, and following a similar procedure cement flyash mortor mixes of 1:3 proportion are casts, cure and tested. The results are shown in table.

3.3 Preparation Of Cement Pozzolime Concrete Specimens

3.3.1 Proportions of concrete:

One proportion of concrete i.e., 1:3:4 has been tried for preparation of cubes the present Investigation. The proportions are nominal by weight.

3.3.2 Replacement of cement by pozzolime:

In the above proportions adopted, pozzolome has been used as replacement of cement. Five percentages of replacement to cement by pozzolime varying from 0% to a maximum of 75% have been tried.

3.4 Preparation Of Cement Flyash Concrete Specimens

3.4.1 Proportion of Concrete:

The Proportions of concrete i.e., 1:2:4 and 1:3:6 have been tried for a proportions of cubes of the present investigation. All the proportions are nominally by weight.

3.4.2 Replacement of cement by fly ash:

In the above proportions adopted, fly ash has been used as replacement of cement. Five percentages of replacement of cement by fly ash varying from 0% to a maximum 60% have been tried.

3.5 Mixing

The various ingredients of concretes were first mixed dry and then adequate amount of water was added and wet mixing was continued to till through mixing was achieved. Required amount of water as to give required consistency and workability was added during mixing. One round of mixing yielded concretes sufficient to casts sixteen cubes of 10 cm size. Sufficient number of cubes required for testing of every mix were cast.

3.6 Casting

Sufficient number of cubes of 10 cm size were cast for each proportion of concrete and for each percentage replacement of cement. The procedure of mixing moulding vibrating and casting the blocks was done on standard lines. The cubes were convenient by numbered with paint for easy identification. The details of mixing and casting.

3.7 Wet Curing

The cubes as available from the casting were left on the moulding platform itself in the open air to allow for air drying for 24 hours. Next curing was commenced by removing the mould and keeping the cube in the curing tanks, to allow for different periods required. The different periods of water curing that is 14, 28, or 90 days were adopt in the cement pozzolime concrete and four different periods of water curing that is 2, 14, 21, & 28 days were adopted in the cement fly ash concretes.

3.8 Testing Of Cubes

The cubes specimen cured as explained above were tested as per standard procedure.

3.8.1 Description Of Compression Testing Machine

The compression testing machine used to determine to crushing strength of cubes is of standard make (AIMIL). The capacity of the machine is 100 tonnes and it is filled with three different ranges of loading (0 to 25, 0 to 50, and 0 to 100). The machine has to facility of control value by using which the rate of loading can be manipulated. The machine was calibrated, and cleaned, oil level was checked and it was kept ready in all respects for testing.

3.8.2 Testing Details

The oil pressure value was closed and the machine was switched on. The uniform rate of loading was maintained. The load was gradually increased as indicated by the pointer. Slightly before the final crushing load was reached cracks (vertical cracks) were found on the sides of the specimen and soon later the cube failed. The maximum load recorded by the pointer was noted. After switching of the machine, the pressure value was released and the crushed specimen was removed. The same procedure was repeated for testing all the specimen. The details of testing are shown in fig.

IV. Results

Table -1 Analysis of Fly Ash

S.NO	DESCRIPTION	TPS KOTHAGUDEM	TPS VIJAYAWADA	TPS RAMAGUNDAM	TPS NELLORE
1	SILICON (Sio2) %	63.3	63.4	65.08	62.5
2	alumin(Al2o3) %	26.75	26.9	21.85	24
3	ferric oxide (Fe2o3)	5.32	3.7	4.07	3.4
4	titasium-di-oxide (TI02)	1.39	1.55	0.9	1.5
5	manganese oxide (Mno)	0.01	0.04	0.02	1
6	calcium oxide (cao)	1.03	1.2	2.09	2.2
7	magnesium oxide (Mg0)	0.48	1.19	1.06	0.05
8	phosphorus pentoxide(p2o5)	0.48	0.05	0.05	-
9	potassium oxide (k2o)	0.52	1.16	1.72	0.85
10	loss of ignition	0.032	0.34	2.6	0.55

Table -2 Sieve Analysis Results For Coarse Aggregate

s.no	I.S. Sieve size	weight retained	cumulative at retained	% cumulative at retained	% cumulative passing
1	80mm	0	0	0	100
2	40mm	0	0	0	100
3	20mm	680	680	13.6	86.4
4	10mm	3730	4410	88.2	11.8
5	4.75mm	590	5000	100	0
6	2.36mm			100	0
7	1.18mm			100	0
8	600mic			100	0
9	300mic			100	0
10	150mic			100	0
11	less than 150mic				
	total	**5000**		**701.8**	

Table -3 Sieve Analysis Results For Fine Aggregate

s.no	I.S. Sieve size	weight retained	cumulative at retained	cumulative % retained	cumulative %passing
1	10mm	0	0	0	100
2	4.75mm	10	10	1	99
3	2.36mm	60	70	7	93
4	1.18mm	310	380	38	62
5	600micron	290	670	67	33
6	300micron	260	930	93	7
7	150micron	70	1000	100	0
8	lower than 150micron		nill		
	Total	**1000**		**306**	

Table -4 Strength Of Motars (1:6)

s.no	cement	percentage replacement of pozzolime in the mix		comp. strength		reduction factor
				14d(n\mm2)	28d(n\mm2)	
1	1	0	0	9.08	11.15	1
2	0.75	0.25	25	6.75	8.65	0.77
3	0.5	0.5	50	4.5	5.85	0.52
4	0.33	0.67	0.67	2.52	3.3	0.3
5	0.25	0.75	0.75	1	1.1	0.1

Table -5 Compressive Strength Of Cement Flyash Motor (1:3)

S.no	% fly ash cement + fly ash content	Compressive Strength			Reduction factor
		3day	7day	28day	
1	0	21.1	31.25	42	1
2	10	20	26.57	37.13	0.88
3	20	16	23.24	35.32	0.87
4	30	13.25	19.38	34.94	0.83
5	40	12.35	16.15	27.32	0.66
6	50	11	13.76	22.89	0.54
7	60	9.5	11.29	20.16	0.48

Table -6 Compressive Strength Of Plain Cement (1:3:4)

S.No	Cement	Pozzolime	% of replacement in the mix	Compressive Strength in N/mm²		
				14 Days	28 Days	90 Days
1	1	0	0	10.5	12.1	14.1
2	0.75	0.25	0.25	9.5	10.5	12.3
3	0.5	0.5	0.5	8.25	8.85	11.45
4	0.33	0.67	0.67	7.25	7.87	10.1
5	0.25	0.75	0.75	5.75	7.31	8

Table -7 Compressive Strength (1:2:4)

S.No	%	Compressive Strength in N/mm²			
		7 days	14 days	21 Days	28 days
1	0	23.75	29	30.5	32.5
2	30	16.75	22.13	24.5	26
3	40	14.5	19	22	23
4	50	12.4	15.25	18.2	21.2
5	60	9.25	11.5	17.25	20.4

Table -8 Design Mix (1:3:6)

S.No	%	Compressive Strength in N / mm²			
		7 Days	14 Days	21 Days	28 Days
1	0	8.4	10.6	11.75	13.65
2	30	6.5	7.8	8.9	10.6
3	40	6	6.8	7.8	9.2
4	50	4.9	4.8	6.8	8.3
5	60	4	4.6	5.5	6.4

Figure - 1

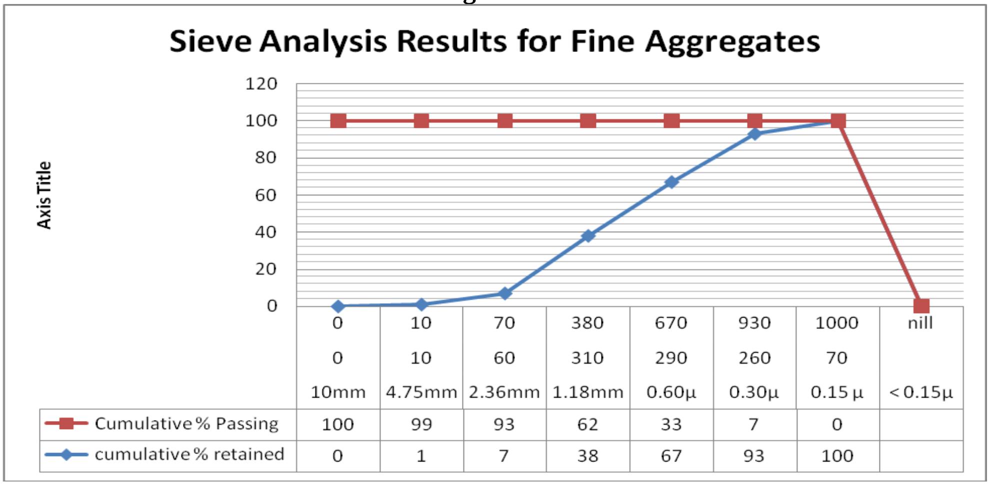


Figure – 2 Sieve Analysis Results For Coarse Aggregate

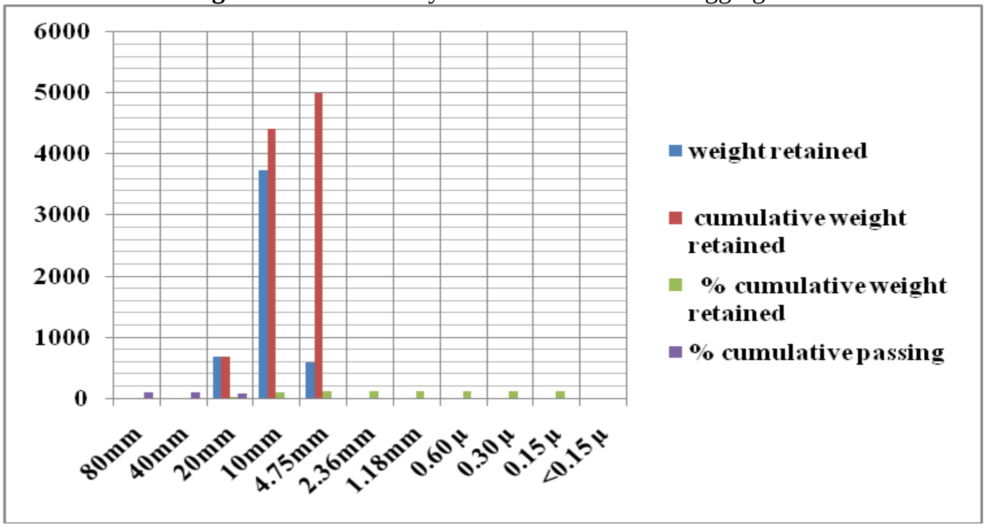


Figure – 3 Compressive Strength of % replacement of Pozzolime

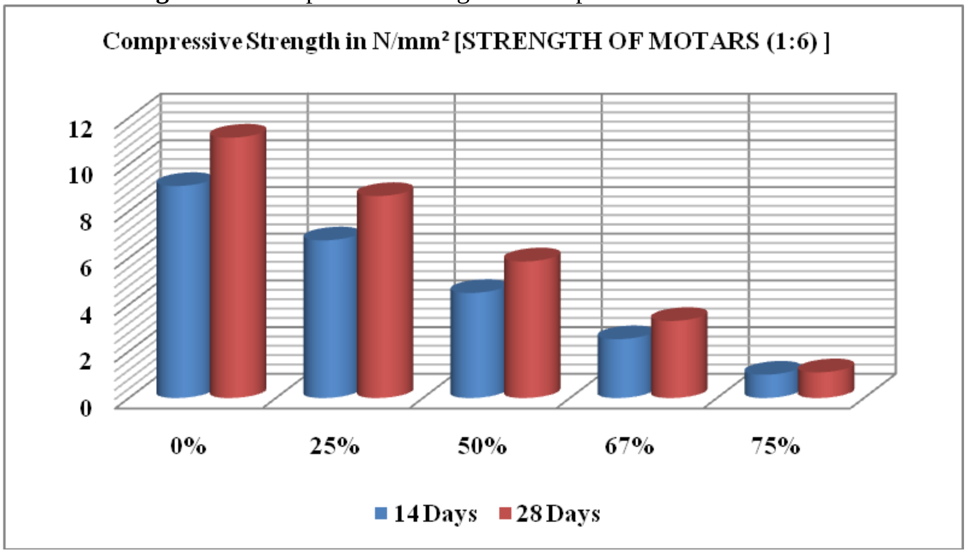


Figure – 4

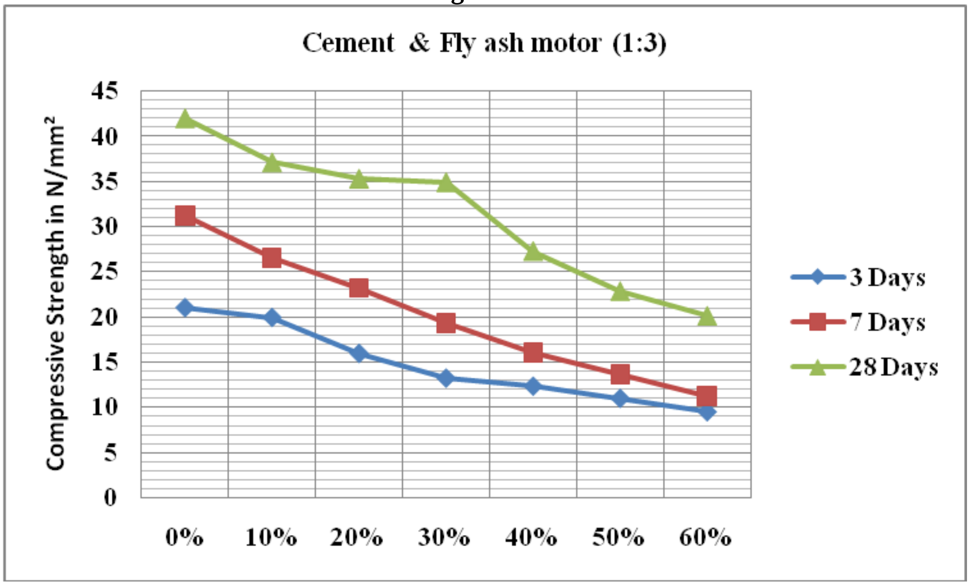


Figure – 5

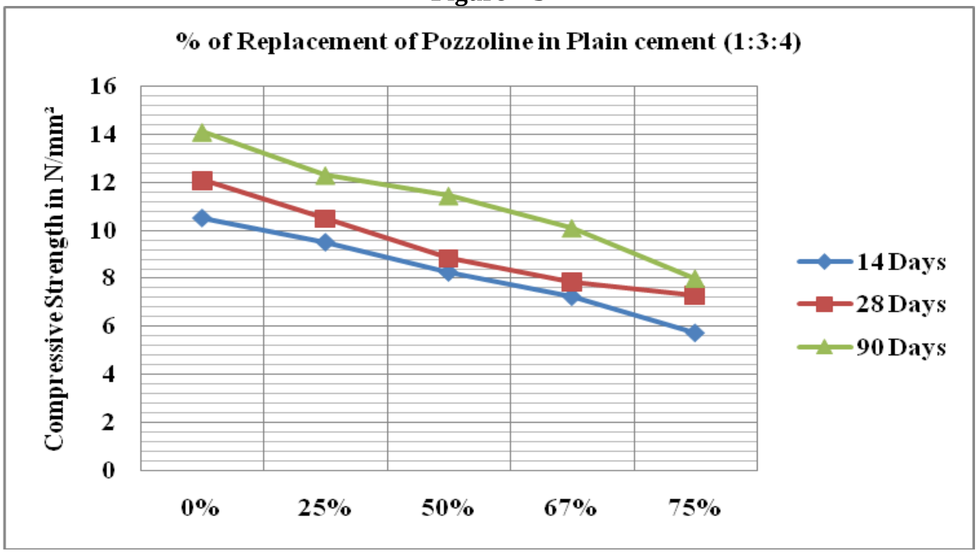


Figure – 6

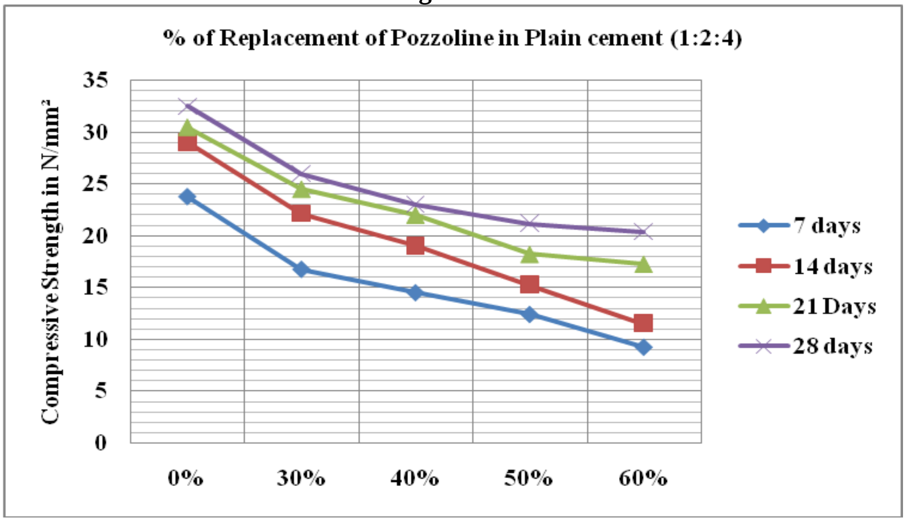
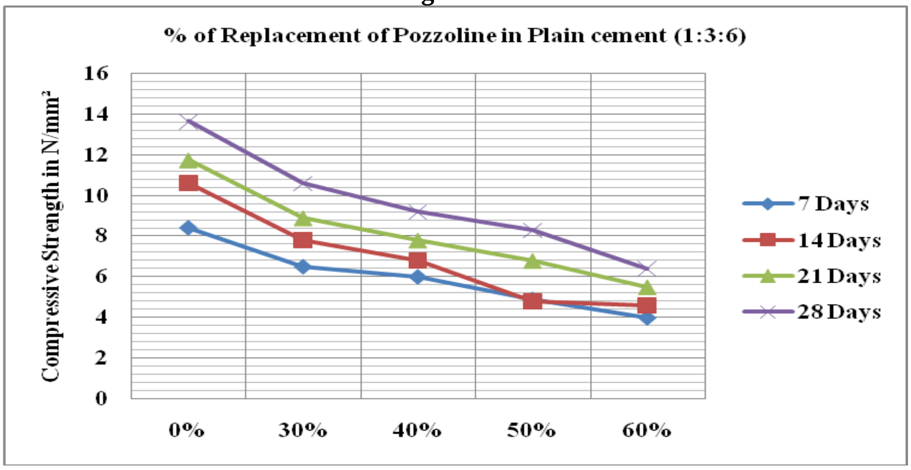


Figure – 7



V. Conclusions

Based on the experimental investigation conducted in the present project work the following conclusions are drawn.

1. For normal masonary construction cement mortor of 1:6 proportion with 67% of pozzolime used as replacement by to cement may be preffered.
2. In the case of cement morter (1:3) with flyash used as replacement to cement with 60% flyash, the strength is reduced nearby 50%. In general, the rate of fall in the strength is less in the case of flyash admixture compared to pozzolime.
3. In general, range of sterength and the strength gaining characteristics under curing conditions are similar in the case of the both the above types of mortors.
4. In the case of pozzolome concrete there is nearly 25% reduction in compressive strength with 50% pozzolime in the mix. This is true at all the ages of concrete.
5. In the case of flyash concrete the 28 days strength is reduced by nearly 20% with 30% flyash. With 60% flyash in the mix this reduction is nearby 50-55%. This is true for both the concrete mixes considered.
6. The pozzolime concrete specimens have shown increased compressive strength at longer ages of curing like 90 days. The 90 days strength of concrete with 50% pozzolime is nearly equal to the 28 days strength of concrete with 0% pozzolime.
7. For concretes with higher percentates of admixture (pozzolime or flyash) curing over longer ages like 60 days or 90 days is required to gain adequate strength.
8. It is recommended that 1:6 cement mortor with 50% pozzolime can be used for practical masonary construction.
9. A practical concrete mix like 1:3:4 with 50% pozzolime can be put to use as its 90 days strength is only 20% is loss compare to that of concrete with 0 percent of pozzolime;

10. In the case of flyash concrete an optimum of 30% of flyash can be tried in the mix as the 28 days strength is reduced by only 20 to 25%. If 50% or more flyash is tried in the mix longer ages of curing like 60 days or 90 days are required.
11. It is finally recommended that pozzolime can be tried as partial replacement to cement in the case of masonary mortors. For concrete; pozzolime can be preferred if the source of flyash is located far away from the site.
12. If source of flyash is nearer to the site then flyash concretes are preferable.

The above recommendations are made based on mainly the strength consideration particularly in the case of pozzolime concretes it is necessary to conduct further studies on properties like durability, chemical resistance, longterm behavior etc before finally deciding on its practical use.

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